Precipitation.—Greatest monthly, 1.70, at Lake Park; least monthly, 0.13, at Thistle.—*G. N. Salisbury, Observer, Weather Bureau, Salt Lake City, director.*

VIRGINIA.

Temperature.—Maximum, 74, at Richmond, 14th; minimum, —2, at Lexington, 8th; greatest monthly range, 65, at Richmond; least monthly range, 48, at Bedford City and Blacksburgh.

Precipitation.—Greatest monthly, 5.95, at Avon; least monthly, 2.99, at Blacksburgh.

Wind.—Prevailing direction, northwest.—*Dr. E. A. Craighill, Lynchburgh, director; J. N. Ryker, Observer, Weather Bureau, assistant.*

WASHINGTON.

Temperature.—The mean was 1.9 above the normal; maximum, 69, at Centerville, 1st; minimum, —9, at Waterville, 11th and 12th; greatest monthly range, 62, at Walla Walla; least monthly range, 23, at Aberdeen.

Precipitation.—The average was 1.82 below the normal; greatest monthly, 13.51, at Neah Bay; least monthly, 0.50, at Waterville.—*E. B. Olney, Observer, Weather Bureau, Olympia, director.*

WEST VIRGINIA.

Temperature.—Maximum, 76, at Morgantown, 1st: minimum, —3, at Tannery, 10th; greatest monthly range, 74, at Morgantown; least monthly range, 43, at Piedmont.

Precipitation.—Greatest monthly, 4.91, at Parkersburgh; least monthly, 1.67, at Romney.

Wind.—Prevailing direction, west.—*W. W. Dent, Observer, Weather Bureau, Parkersburgh, director.*

WISCONSIN.

Temperature.—Maximum, 58, at Prairie du Chien, 25th; minimum, —45, at Haywards, 19th; greatest monthly range, 84, at Barron and Butternut; least monthly range, 51, at Beaver Dam.

Precipitation.—Greatest monthly, 3.38, at New Holstein; least monthly, 0.07, at Osceola Mills.

Wind.—Prevailing direction, northwest.—*W. L. Moore, Local Forecast Official, Weather Bureau, Milwaukee, director.*

WYOMING.

Temperature.—The mean was slightly below the normal; maximum, 72, at Casper, 24th; minimum, —44, at Fort Fetterman, 11th; greatest monthly range, 112, at Fort Fetterman; least monthly range, 70, at Evanston.

Precipitation.—The average was slightly above the normal; greatest monthly, 1.21, at Lusk; least monthly, 0.00, at Bitter Creek.

Wind.—Prevailing direction, west.—*E. M. Ravenscraft, Observer, Weather Bureau, Cheyenne, director.*

CONTRIBUTIONS AND ORIGINAL ARTICLES.

CHINOOK WINDS.

[By E. B. GARRIOTT, Weather Bureau.]

Winds of a peculiar type, characterized by unusual warmth and dryness, occur during the colder months in various parts of the globe. The *Chinooks* of the northwestern part of the United States, the *Fœhn* of Switzerland, and the *Zonda* of the Argentine Republic belong to this type.

The *Chinooks* are warm, dry winds, often of considerable force, which sweep over districts east of the principal mountain ranges of the northwestern part of the United States. Their occurrence is confined to the colder months. They are felt as far south as the middle-eastern slope of the Rocky Mountains; but are more pronounced on the northeast slope, which embraces Montana and the southern Saskatchewan valley.

The *Chinooks* are storm winds, and belong to the wind system of regular cyclonic areas. From October to March, inclusive, a principal track of low pressure areas or general storms lies north of Washington, Idaho, and Montana. The passage of these storms is attended in districts to the southward by westerly winds whose strength is proportional to the energy of the cyclonic disturbance, whose force diminishes as the distance from the center of disturbance increases, and whose duration depends upon the velocity of the storm-center.

The winter temperatures in Montana are among the lowest noted in the United States. With the approach of a low pressure storm from the north Pacific coast, and preceding the appearance or development of such a storm in extreme western British America, high pressure and low temperature obtain over the northeast slope of the Rocky Mountains, and a high pressure area usually occupies the middle plateau region. As the low area approaches or extends its influence rain will set in on the north Pacific coast; the temperature will be 40° to 50° in that district; and a temperature gradient or difference of 40°, or more, will be shown between the regions to the east and west of the Rocky Mountains. In low areas of pronounced strength the cyclonic indraught causes westerly winds from the mountains over Montana and southern Alberta; the cold air to the leeward of the mountains is withdrawn by the general movement of the lower atmosphere, and is replaced by air from the windward side. Following the march of the mass of warm, moist air from west of the Rocky Mountains we find that it reaches the windward side with temperature 40°, or more, higher than the temperature of the air to the leeward. Forced to the summit it loses heat by expansion and moisture by condensation of aqueous vapor by the cold of elevation, the latter operation being attended by the liberation of more or less latent heat, which has the effect of modifying to some extent the chilling process. In descending the leeward side to replace the air removed by the westerly winds it acquires heat by compression. If the loss of heat by expansion in the ascent is compensated by the gain by compression in the descent, the air forced over the mountains assumes practically the same temperature it had before the ascent was commenced, and is 40°, or more, warmer than the air it replaced.

These warm, and in the case above mentioned dried, winds sweep eastward with the advance of the storm-center. Their eastward limit depends upon the movement and character of the general storm, and also upon the condition of the ground over which they pass as regards dryness and moisture. If the ground is covered with snow much heat is lost in the process of evaporation. The snow is melted by the warmth, and the liberated moisture is absorbed be the dry air. In such cases the air is gradually chilled, and the temperature rise is less marked as the distance traveled by the crest of the warm wave increases.

A remarkable feature of the *Chinooks* is the marked temperature rise which attends their arrival. Thermograph record sheets show an almost vertical line of ascent covering 40° to 50°, and reports indicate that an increase of 70° to 80° in six to eight hours is not uncommon.

The *Chinooks* occur under well-defined meteorological conditions, and a forecast of their approach is not more difficult than a prediction of warmer weather for the eastern part of the country.

When conditions are favorable the warm winds of the Northwest are supplemented by warm air drawn by the cyclonic indraught from southern latitudes of the central valleys. The *Chinook contingent* is re-enforced, and the warm condition or warm wave accompanies the low pressure area in its advance to the Atlantic coast.

Warm, dry winds are not uncommon on the middle-eastern slope of the Rocky Mountains. The cyclonic system of winds is also the cause of their origin in that region. The temperature conditions preceding their occurrence are somewhat similar to those observed in connection with the *Chinooks* of the Northwest. A body of cold air occupies the districts on the leeward side of the mountains, and the air to the windward shows comparatively higher temperature. The air from the elevated plateau is forced over the mountains and gains heat by compression during the descent on the leeward side.

In the warmer months conditions for the development of the *Chinooks*, as warm winds, rarely exist. Cyclonic areas seldom pass from the north Pacific Ocean over the Saskatchewan Valley during that season. In summer the northeast slope of the Rocky Mountains is one of the warmest and the north Pacific coast is one of the coolest districts in the United States. With the passage of a storm-center north of the *Chinook* region the wind would blow, not from a warm to a cold region, but from a cool to a much warmer region. To the leeward of the mountains it would be a cooler rather than a warmer wind.

Following a period of intense cold the *Chinook* wind is a welcome visitor in the Northwest. The icy clutch of winter is loosened. The earth throws off its winding-sheet of snow. Humanity ventures forth to inhale the balmy, spring-like air. Animate nature rejoices.

A notable *Chinook* wind was experienced in the Northwest January 19, 1892. A graphic illustration of the temperature change due to this wind is shown by a copy of a section of the thermograph record sheet at Fort Assinaboine, Mont., which appears in a description of low area VIII in this REVIEW. This record shows a temperature rise of about 43° in fifteen minutes, and a rise of about 49° in less than three hours. Chart VII with this number of the REVIEW shows the general meteorological conditions west of the 95th meridian at the 8 p. m. report of January 18th, which preceded, and at the 8 a. m. report of January 19th, which followed, the arrival of the *Chinook* at Fort Assinaboine. Under low area VIII a description of these charts is included in a general description of the meteorological conditions which obtained in the Northwest during January 18 and 19, 1892.